Materials and Reuse

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Idea: Repurpose Microelectronics From Ubiquitous Consumer Goods

The Washington Post

ECONOMY

Sanctions forcing Russia to use appliance parts in military gear, U.S. says

With Western technology sales banned, Russia is using computer chips meant for household appliances in battlefield gear, Commerce secretary tells a Senate hearing

3 min 1197

By Jeanne Whalen

May 11, 2022 at 5:33 p.m. EDT

U.S.-led sanctions are forcing Russia to use computer chips from dishwashers and refrigerators in some military equipment, Commerce Secretary Gina Raimondo said Wednesday.

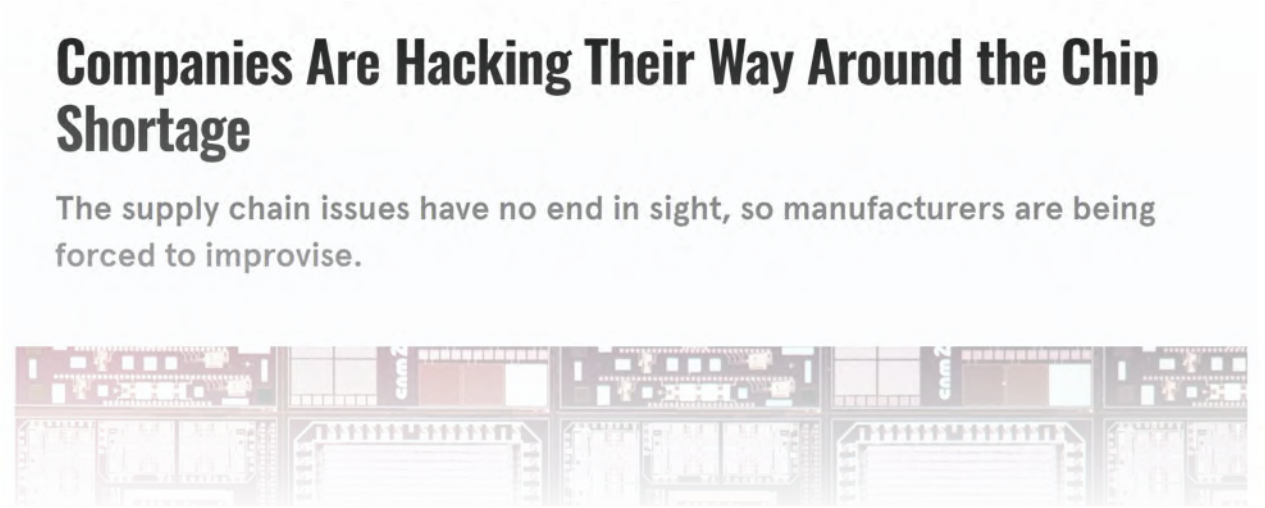
"We have reports from Ukrainians that when they find Russian military equipment on the ground, it's filled with semiconductors that they took out of dishwashers and refrigerators," Raimondo told a Senate hearing, noting that

"... Russian military equipment ... filled with semiconductors that they took out of dishwashers and refrigerators."

– Commerce Secretary Raimondo, 2022

Upset Supply Chains for Semiconductors: Not Just a DoD Problem

WIRED (2022)



Companies Are Hacking Their Way Around the Chip Shortage

The supply chain issues have no end in sight, so manufacturers are being forced to improvise.

"There's desperation in the market. If you're building a $350,000 mass spectrometer, and you can't ship it because you don't have a 50-cent chip, you're pretty much willing to pay anything." - McKinsey & Company

"One large industrial conglomerate had resorted to buying washing machines just to scavenge the chips inside them for its products." - ASML CEO

A capability to rapidly adapt products to available microelectronics would harden the economy to supply chain disruptions

https://www.wired.com/story/chip-shortage-hacks/

An Idea

Rather than trying to fabricate advanced node electronics in the field, could we scavenge chips from ubiquitous electronics and repurpose them?

Why is that hard?

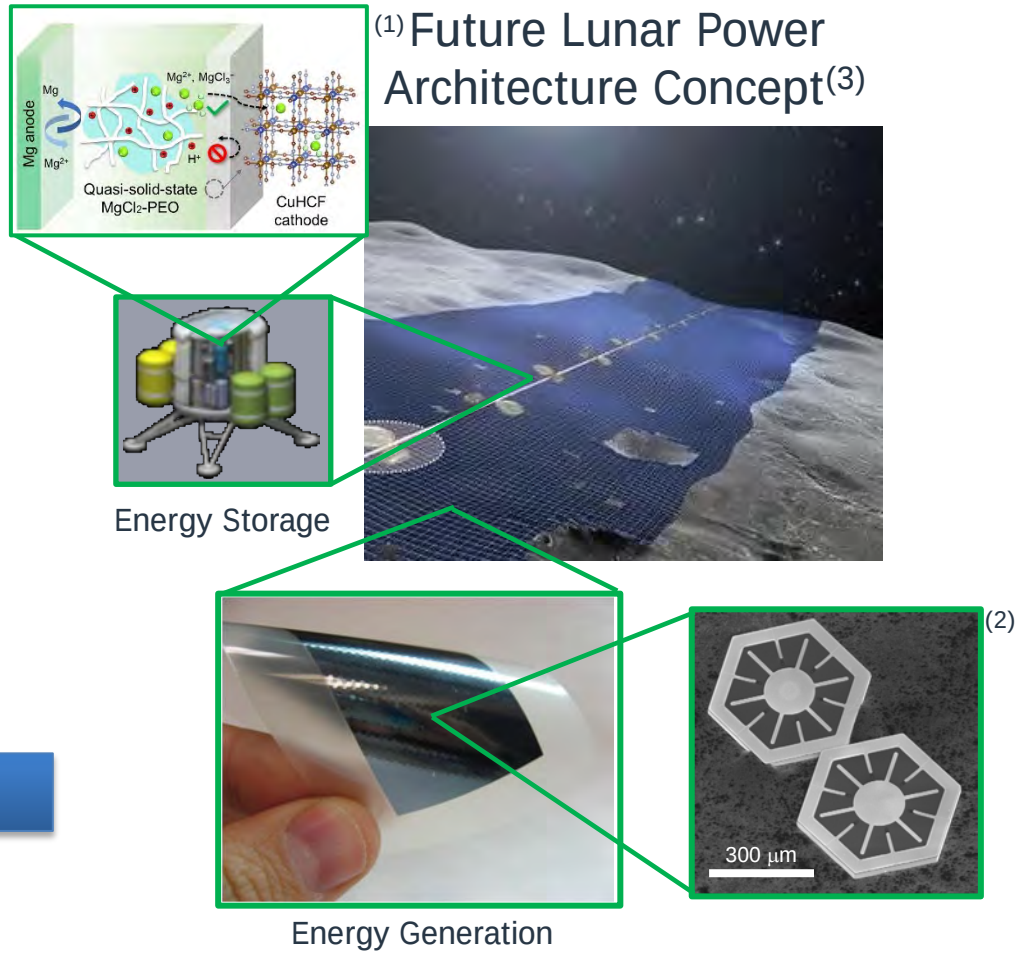
- Automated design constrained by available parts
- Sourcing electronic-grade materials
- Reassembly into high performance circuits
- Test and debug
- Software

Enabling the Lunar Infrastructure

- A lunar economy requires abundant and distributed power
- Can we produce photovoltaic-grade Si from lunar regolith?
- Can we manufacture thousands of acres of photovoltaic arrays?
- Can we develop new chemistries to store energy using lunar-abundant materials?
- Other opportunities:
  - Cryo temperatures for superconducting transmission lines
  - Lunar dust management

Because (lunar) economic security is national security

(1) Future Lunar Power Architecture Concept(3)

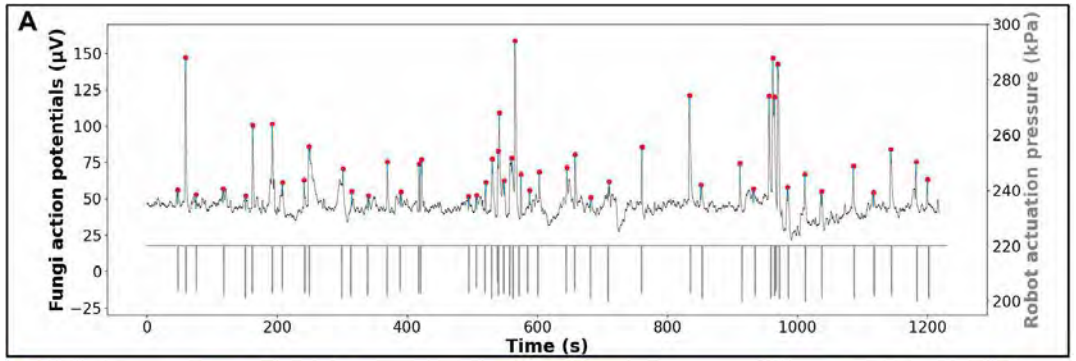


(1) Leong KW, *et al.*, Science Advances, 2023.
(2) "Microsystems Enabled Photovoltaics (MEPV)," Sandia National Laboratories, 2012.
(3) NASA 2023 (https://techport.nasa.gov/file/143282)

Living Microsystems for Computing, Sensing, and Control

- Demonstrations of fungi controlling robots suggest opportunities in unconventional computing
- Can fungi be used for sensing and communications?
- What are the limits of fungi as control elements in a system?
- Are we limited by our ability to interface with these systems?
- Can fungi be trained? Can they be grown such that they are trained?

Spontaneous spiking currents in fungal samples to control soft robot



(1) Adamatzky A, Interface Focus, 2018.
(2) Danninger D, *et al.*, Science Advances, 2022.
(3) Shepherd R, Science Robotics, 2024

www.darpa.mil